

INSTALLATION DEVICE FOR CONNECTING SHELL-SHAPED
LONGITUDINAL SEGMENTS OF A JACKET BODY BY PLACEMENT OF AT
LEAST ONE LONGITUDINAL CONNECTION SEAM

5 The invention relates to an installation device for connecting shell-shaped longitudinal jacket segments of a jacket body that forms a large component that extends longitudinally, that determines a hollow space with an open face, and that is closed in particular on the circumferential side, by placement of at least one longitudinal connection seam on the body jacket, said installation device comprising
10 at least one tool pair which comprises an inner tool that is movably guided within the hollow space in longitudinal direction of the jacket body, and further comprises an outer tool that is movably guided outside the hollow space in longitudinal direction of the jacket body, wherein for the purpose of producing the connection seam the tools act together as a pair in the direction across the longitudinal direction of the
15 body. Typically the jacket bodies are aircraft fuselages that are installed from a plural number of partially cylindrical prefabricated shell segments. The segments are placed in positions that determine the fuselage and are longitudinally joined by means of riveted seams. For the purpose of producing the riveted seams a group of tools are used that are arranged on movable tool units. Such units comprise, for example, tools
20 for boring, countersinking, sealing, plugging, pressing and holding-up. Generally speaking, the device can be equipped with any desirable tools for producing connection seams or for processing corresponding connection points.

A generic automatic installation device that is for example known from US 4 662
25 556 comprises mounting carriages that carry tool units, which mounting carriages are arranged so as to be movable on rails in longitudinal direction of the fuselage. With the stationary mounting carriage device, riveted seams can essentially be placed only in one circumferential height position so that the fuselage body to be produced has to be displaced so that it can be completed with further segments. Another installation
30 device, known from US 4 662 556, that produces riveted connections comprises a rail scaffold that has been formed according to the circumferential contour of the fuselage. Carriages that guide and move a beam that carries an outside tool, said beam extending along the fuselage length, run on curved rail sections. For the purpose of processing a riveted seam in a circumferential height position the
35 longitudinal beam is attached to the fuselage, and riveting counter-tools in the interior of the fuselage are connected to the longitudinal beam by way of pins placed through the fuselage shell. Undesirable forces are introduced into the component to be produced. While the installation device makes it possible to produce longitudinal

riveted seams in different circumferential positions of a semi-fuselage, setting up and retooling are however particularly time consuming and labour-intensive. The curved rail guide has to be constructed depending on the dimension and shape of the fuselage to be produced, so that the device can only be set up and used for a single design type. The overall construction is expensive and only covers half the circumference of the fuselage.

It is thus an object of the invention to provide an automatic installation device of the type described, which device is to be relatively simple in its construction and is to be usable for producing longitudinally-segmented jacket bodies of various diameters or forms, wherein the longitudinal connection seams are to be processed and produced at the largest possible circumferential angle region on the body jacket in the desired circumferential position. The effort required for setting-up and installation is to be reduced, and correspondingly the time and expenditure involved in production are to be reduced.

The object of the invention is met in conjunction with the features of the installation device mentioned in the introduction in that the installation device comprises a carrier pair that is formed by an inner guide carrier that extends in longitudinal direction in the hollow space of the jacket body, which inner guide carrier movably guides the inner tool, as well as being formed by an outer guide carrier that extends in longitudinal direction outside the jacket body, which outer guide carrier movably guides the outer tool, wherein each guide carrier is rotationally held and fastenable on at least one longitudinal rotary axis that is oriented according to the outer longitudinal contour of the jacket body as well as being held and fastenable in at least two separate spatial directions extending across the longitudinal direction such that tools that interact as a pair, for the purpose of producing the connection seam, selectively take up different positions on the longitudinal circumference of the jacket body. According to the invention the tools that work towards each other as a pair are movable by rotation on associated longitudinal axes as well as by means of independent displacement in at least two directions across the longitudinal axis of the body to desired circumferential positions on the jacket of the body to be produced. By means of rotary adjustment of the tool guide carriers the working axes of the tools can be aligned in the desired height position / circumferential position to the region of the jacket segments to be connected, wherein predominantly 90° alignment is provided. In particular, riveting tools work in a working alignment at a 90° angle in

relation to the generated surface on the seam position. The device according to the invention is particularly suitable for this application because the circumferential positions / height positions can be slidably set while the operating angle positions can be set in a rotatory manner without mutually influencing each other. This demonstrates that the device is universally usable for producing hollow jacket bodies of various sizes and cross-sectional shapes because the tool pair or the tool pairs can practically be moved to any desired height position and circumferential position. In particular, one and the same installation device can be provided for producing fuselages of various aircraft types. There is no longer a need to construct devices for each size type and/or shape type. Machining costs, setting-up costs and production times are significantly reduced. Furthermore, the degree of automation for producing hollow jacket bodies with segment parts can be increased because connection seams can be produced with free tools in one and the same manner. There is no longer any need to carry out conventional manual setting-up and installation work.

In a preferred design according to the invention each tool guide carrier is rotatably displaceable on the associated longitudinal rotary axis and is displaceable to and fro in two separate transverse directions that are arranged so as to be perpendicular in relation to each other. In this way the tools, direction by direction, can be brought into the Y- direction and the Z-direction of a cartesian coordinate system in the desired height position and circumferential position, and by rotary adjustment, for alignment of their working axes, can be set precisely in relation to the surface of the jacket segments to be connected.

The device according to the invention can particularly advantageously be used for producing bodies whose longitudinal segments are partially cylindrical. Likewise, hollow jacket bodies of a diameter that differs from the cross-section of the cylinder can be produced without further ado. In particular, bodies with changing profile cross sections, in particular with conical longitudinal sections, can be produced. To this effect the tool guide carriers are held in such a way that they are rotatable on longitudinal rotary axes that are oriented according to various outer longitudinal contours of the jacket body.

A particularly preferred and advantageous design of the invention consists of the installation device comprising a carrier frame that extends in longitudinal direction, which carrier frame forms the carrier pair, and is rotatably held on a bearing axis that

preferably coincides with a longitudinal symmetry axis of the carrier frame, which bearing axis forms a common longitudinal rotary axis for the two tool guide carriers. This embodiment provides a particular advantage in that the inner tool guide carrier and the outer tool guide carrier are mechanically integrated in a single body, namely

5 in the carrier frame. Expediently, the carrier frame is closed so as to optimise both force introduction and force distribution. This results in a tool working system that is non-positive per se, in which the tools that work towards each other as a pair are mutually supported with optimum force balancing. On the one hand, relatively great forces can act on the tools. This is particularly advantageous with the use of

10 squeezing tools that join dural rivets or similar rivets, so as to prevent any introduction of force into components to be connected. To this extent dural rivets also provide an advantage in that they are available economically, in that they do not require preformed holes, and in that the tolerance of the tool centre point is relatively large. In this way excellent riveting rates can be achieved during production. On the

15 other hand, components such as the carrier frame, the bearings, mounting parts and/or tool carrier heads that hold said carrier frame can be dimensioned so as to be smaller. By integrating the tool guide carriers in the carrier frame the overall construction is relatively simple. A mounting that holds the carrier frame, as well as the bearing arrangement are arranged in a space-saving manner with a minimum

20 number of components.

In particular, with the device according to the invention it is possible to place connection seams to jacket bodies that are completely closed on the circumferential side. With a design according to the invention this can also be achieved with a closed

25 carrier frame. In a design according to the invention such a carrier frame at its faces comprises the frame webs that connect the two guide carriers, which frame webs are rotatably held by at least one longitudinal axis of the carrier frame, and on at least one frame end the frame web is detachably connected to the frame guide carriers so that said frame web in the detached state can be moved to a position that provides

30 access to a front space in front of the inner guide carrier. Expediently, the carrier frame can be opened in that the detachable frame web can be completely detached from the frame and by means of a column-like mounting part can be moved to a position that leaves free space in order to place the open-faced and circumferentially closed jacket body in a preassembled form, or part of said jacket body, from one face

35 into the device, or to remove it from there. Expediently, at its face that remains closed the carrier frame is provided with a weight mass that generates a

counterbalance weight so as to hold the carrier frame in position in the state where the frame web is completely separated from the frame guide carriers.

5 In order to be able to place a longitudinal seam also in jacket bodies whose profile cross section varies, the invention expediently provides for the carrier frame to be held in such a way that it can be relocated as desired to at least two positions in which each of the frame guide carriers is aligned according to the different outer longitudinal contour of the jacket body. Advantageously a bearing device that holds the carrier frame is provided, which bearing device on the frame webs in their
10 direction of extension comprises curved, e.g. convex, bearing sections, as well as corresponding, e.g. concave, bearing sections that accommodate said convex bearing sections.

15 In order to provide a particularly favourable device, as far as its design shape and size are concerned, with a carrier frame that integrates the tool guide carriers, in a design according to the invention two column-like mounting parts are provided, between which the carrier frame is arranged, and on which mounting parts said carrier frame is held so as to be rotatable on a longitudinal axis. The column-like mounting parts are arranged so as to be mutually movable in particular on rails
20 across the longitudinal direction of the jacket body, in at least one first spatial direction. In order to hold the frame carrier so that it is height-adjustable in a particularly simple manner, one embodiment of the invention provides for the column-like mounting parts to carry bearings that hold the frame carrier and that are adjustable in spatial direction across the longitudinal direction of the jacket body as
25 far as the column height of the mounting parts is concerned.

According to a further embodiment of the invention, instead of the frame that integrates the tool guide carriers, a device comprising an inner portal device and an outer portal device is provided. The inner portal device holds at least one inner guide
30 carrier, while the outer portal device holds at least one outer guide carrier, wherein the inner guide carrier is rotatably adjustable on a longitudinal rotary axis of the inner portal device, while the outer guide carrier is rotatably adjustable on a longitudinal rotary axis of the outer portal device, which rotary axis expediently is parallel to the inner portal longitudinal rotary axis. Expediently, in each case the
35 inner portal device and the outer portal device comprise two column-like mounting parts, between which in each case the associated portal carrier is arranged and on

which mounting parts said associated portal carrier is held, wherein the column-like mounting parts of each portal device are arranged so as to be movable in at least a first spatial direction across the longitudinal direction of the jacket body and are arranged so as to be fastenable, and carry rotary bearings, each of which holds the portal carrier, and in at least one second spatial direction across the longitudinal direction of the jacket body are adjustable as far as the column height of the mounting parts is concerned.

In order to bring a circumferentially closed prefabricated jacket body or part thereof from a face to the installation device, or in order to remove said jacket body from there, according to one embodiment of the invention the inner portal device comprises a first column-like mounting part on which the inner portal carrier is pivotably held in the direction of the column height. The portal device also comprises a second column-like mounting part on which the inner portal carrier is held so that it can be lifted off for pivoting removal, wherein the second column-like mounting part can be moved across the longitudinal direction of the jacket body to such an extent that the facing space in front of the inner portal carrier is released.

In the embodiment according to the invention with the two portal devices too, special means can also be provided in order to place longitudinal seams on sections with varying longitudinal contours or with different cross sectional profiles. To this effect, on the above-mentioned column-like mounting parts of the inner portal carrier device and of the outer portal carrier device height-adjustable and arrestable support bearings for the portal carriers are arranged in such a way that said portal carriers in parallel position in relation to each other can selectively be moved to at least two positions that are adaptable to the various longitudinal contours.

Subordinate claims deal with the above-mentioned and with further expedient and advantageous embodiments of the invention. Particularly expedient and advantageous embodiments or embodiment options of the invention are described in more detail with reference to the following description of the exemplary embodiments shown in the diagrammatic drawings.

Figs 1 and 2 show a longitudinal view of one embodiment of an installation device according to the invention with frame carrier;

- Fig. 3 shows a top view of a setting-up position of the installation device of Figs 1 and 2;
- 5 Figs 4 and 5 show a longitudinal view and top view of the installation device of Figs 1 to 3 in a setting position;
- Figs 6A to 6C show a front view of setting positions of the installation device of Figs 1 to 5;
- 10 Fig. 7 shows a profile view of tool setting positions of installation devices according to the invention, on hollow jacket bodies of different circumference.
- 15 Figs 8 and 9 show a longitudinal view and top view of an exemplary embodiment of an installation device according to the invention;
- Figs 10 and 11 show a longitudinal view and top view of a setting-up position of the installation device of Figs 8 and 9;
- 20 Figs 12A to 12C show a front view of setting positions of the installation device of Figs 8 to 11; and
- Fig. 13 shows a longitudinal view of a setting position of the installation device of Figs 8 to 12.
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- An installation device 1, 11 according to the invention, shown by means of Figs 1 to 6, comprises a mounting 6 with a tool frame-carrier 4 held on it. Two mounting parts that are movable, either separately or together, as desired, in the Y-direction on rails 14 are designed as columns or towers 61, 62 that extend in the height direction Z.
- 30 The carrier frame 4 extends in the direction of the third cartesian coordinate X and by way of end pieces 43, 44 that form frame webs is slidable in height direction Z, and is rotationally held, on a centre axis and symmetry axis 40 of the frame carrier, to the towers 61, 62 by means of the bearing device 51. The installation device 11 is used for joining partially cylindrical shell-shaped longitudinal segments 910 by placement
- 35 of longitudinal riveted seams 97 to a jacket body, closed on the circumference, with open faces in the form of a fuselage 9, as shown in Figs 6A to 6C. These figures

show the fuselage 9 of an aircraft, which fuselage has a circular cylindrical profile cross section. In the interior, the fuselage 9, at approximately half its height, is divided into an above floor area and an underfloor area by means of a horizontal floor 93. The fuselage 9 with its cylindrical axis 90 extends in the X-direction. The
5 longitudinal direction L of the installation device 11 as well as the longitudinal direction of the fuselage 9 are mutually determined by the X-direction.

To install the fuselage 9 it is prefabricated in the shape shown in Figs 6A to 6C and in a way that will be described in further detail is placed in the installation device 11
10 on a component carriage 13, which for example is movable along a guide 17 in the X-direction. In this state the longitudinal segments 910 – Figs 6A to 6C show lateral sections – are bonded together at their longitudinal margins. In order to complete this longitudinal connection, the longitudinal riveted seams 97 are produced at the overlapping positions. Such riveted seams are produced in a way that is known per se
15 by inner tools 31 and outer tools 32 that work towards each other as a pair and are movable across the longitudinal direction L of the body. The work units or tool units comprise in particular tools for boring, countersinking, sealing, plugging, pressing and holding-up, which tools for the purpose of carrying out the individual work steps are automatically selected, moved and activated. For example, each of the riveted
20 connections which in Figs 6A to 6C in the overlapping position of the segments 910 are diagrammatically represented by the character X comprises three longitudinally parallel riveting lines.

According to the invention the installation device 11 comprises a carrier pair 2 that is
25 formed by an inner guide carrier 21 which in the hollow space 92 of the fuselage 9 extends in the X-direction and movably guides an inner tool carriage 310, as well as a by an outer guide carrier 22 which extends in the X-direction and movably guides an outer tool carriage 320 . In the exemplary embodiment of Figs 1 to 6 the carrier pair 2 is formed by the carrier frame 4. Longitudinal parts 41, 42 of the frame 4,
30 which longitudinal parts 41, 42 extend parallel to the straight longitudinal contour 980 of the fuselage 9, form the two guide carriers 21, 22 which at their faces are non-positively connected to the end pieces 43, 44. The frame 4 or the frame guide carriers 41, 42 are of such a length that the longitudinal path of each tool carriage 310, 320 covers the full length of the fuselage 9 to be processed. Furthermore, the tool
35 carriages 310, 320 as a pair are arranged so that they are movable towards each other so that a multitude of tools 31, 32 for producing the riveted seam 97 can be moved

from the inside or the outside to the jacket wall 91 of the fuselage 9, where they work towards each other with automatically selected tools for the purpose of processing the seam. For this purpose individual tools 31, 32 are locally also movable on the tool carriages 310, 320 in longitudinal direction and in cross direction.

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The frame bearing device 51 comprises a pair of rotary-ring bearings 511. Each bearing 511 is height adjustable and arrestable on the associated tower 61, 62 in a vertical groove 63 in the Z-direction. In order to hold the carrier frame 4 with the end pieces 43, 44 the two rotary-ring bearings 511 in the Z-(height) direction and the Y-direction are moved to corresponding positions. In each Y, Z-position the frame 4 is rotatable on its centre longitudinal axis 40 that coincides with the rotary axis 500 of the bearing device 51. Correspondingly the inner tool guide carrier 21, 41 and the outer tool guide carrier 22, 42 are rotatably held on one and the same longitudinal rotary axis 500. By rotating the frame 4 on the rotary axis 500, opposing tool carriages 310, 320 that are aligned with each other, or tools 31, 32 that oppose each other as a pair 3 are movable by a single rotary adjustment movement to any desired rotary angle position. In combination with the mutual movability of the towers 61, 62 of the mounting 6 in Y-direction, as well as the mutual height adjustability of the rotary-ring bearings 511 in Z-direction, the frame 4 can be moved to any desired height position or circumferential position on the fuselage jacket 91, as is in particular shown in Figs 6A to 6C, wherein by rotary adjustment of the frame 4 in the direction R1 the tool carriages 310, 320 or their tools 31, 32 can be placed in a working direction that is aligned so as to be perpendicular in relation to the generated surface of the fuselage 9. This positioning is achieved by the independent adjustment paths that are set up in the Y-direction, Z-direction and R1-direction. In the device 1 the two to-and-fro movements as well as the rotatory movement are carried out by automatic control according to the size and shape of the fuselage 9, as well as according to the circumferential position of the riveted seam to be placed. In each of the set tool working positions the towers 61, 62 or the bearings 511 are arrested with the usual means (not shown).

Figs 6A to 6C show two working positions in the above floor area and one working position in the underfloor area of the fuselage 9. In each case a riveted connection seam 9 is produced in that the two tool carriages 310, 320 are moved to and fro in the firmly set positions of the tool guide carriers 41, 42 alongside them as a pair, wherein

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the individual work processes of the tools 31, 32 that are guided in pairs towards each other are automatically controlled, selected, activated and carried out.

To demonstrate the universal use of the installation device 1, Fig. 7 shows cylindrical
5 fuselages 9 of different size and shape with guide carrier pairs 2 or tool pairs 3 that
are moved to selected processing positions 191 to 198. The figure shows that with
one and the same installation device 1 the processing positions with 90° tool
positions can for example be set up on fuselage bodies with circular cross sections of
widely different sizes and on jacket bodies that are oval in cross section. For
10 example, smaller fuselages have diameters of less than 4 m while larger fuselages
have diameters of more than 7 m. With the automatic riveting machine according to
the invention, longitudinal seams can be placed on any desired circumferential
position, on cylindrical components as well as on jacket bodies that are non-
cylindrical of any diameter and shape.

15 In order to provide one and the same installation device 1 according to the invention
for a wide spectrum of applications, the automatically movable and adjustable parts
of the device will be designed and implemented such that the pair 2 of the guide
carriers 21, 22 is relocatable along a circumferential section of the jacket, which
20 section corresponds to a circumferential angle of at least 200° to 300°.

The fuselages shown in Figs 6 and 7 comprise a central floor 93, or in the exemplary
embodiment of the oval fuselage, comprise two floors 95, 96. In order to be able to
move the pairs 2 of guide carriers or the pairs 3 of tools on such fuselages 9 in any
25 floor region to the desired height position, a change in plane has to be undertaken.
For this purpose the fuselage 9 must be moved out of the region of the carrier pair 2
or of the frame 4 and, after a change in the height position of the carrier pair 2, must
be moved into the new floor region. The measures that are required for this, which
measures are also provided in order to move into the device 11 the circumferentially
30 completely closed fuselage 9 that is open at the faces, are described below in the
context of the exemplary embodiment.

As shown in Figs 2 and 3 the frame end piece 43 is detachably attached to the frame
guide carriers 41, 42. The end piece 43 that is decoupled from the guide carriers 41,
35 42 is moved in the Y-direction by means of the tower 61, wherein the end piece 43
remains connected to the bearing 511. For attachment of the end piece 43 to the

frame guide carriers 41, 42 any detachable mechanical connection-means that establishes a non-positive connection can be considered. In this arrangement the connection is established in that the towers 61 and 62 remain arranged at a fixed distance from each other in the X-direction.

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In Fig. 2 the frame 4 with the guide carriers 41, 42 is in a vertical position that corresponds to the Z-direction. The tower 61 with the end piece 43 decoupled from the carriers 41, 42 is moved back in the Y-direction so that the frame 4 that remains in elongated U-shape in front of the open face end is completely free. The jacket 91
10 of the fuselage 9, which fuselage 9 circumferentially is completely closed and which fuselage 9 rests on the component carriage 13, by longitudinally moving the carriage 13 in the X-direction is moved between the frame guide carriers 41, 42 or conversely is moved out of such a position. In the top view of Fig. 3 the frame 4 is shown in a horizontal position that corresponds to the X-Y-plane. It is evident that the tower 61
15 with the end piece 43 is moved in the Y-direction to such an extent that the circumferentially closed fuselage 9 can comfortably be moved freely over the inner tool guide carrier 41.

In order to change the height plane of the inner tool guide carrier 41, after moving
20 the fuselage 9 out of the region of the frame 4, the two end piece bearings 511 on the towers 61, 62 are moved to the same desired extent in height in the Z-direction and are positioned. In this procedure the rotary position of the end piece 43 and of the open U-frame part on the rotary axes of the bearings 511 remains so that the frame 4 in a simple way is closed again in that the tower 61 is moved back to the y-position
25 that corresponds to the tower 62.

In the exemplary embodiment of Figs 1 to 6 the rotary bearing 511, which is height-adjustable in Z-direction, on the tower 62 is connected to a weight mass 45 in such a way that a counterweight which counterbalances the weight of the U-frame part acts
30 to hold the U-frame part with favourable force distribution to the bearing of the tower 62 in its cantilever position.

As shown in the top view in Fig. 5 the parallel tool guide carrier 41, 42 of the frame 4 is aligned in a direction that corresponds to the longitudinal contour 990 of a
35 conical end section 99 of a fuselage 9. This means that the guide carriers 41, 42 and the straight contour line of the conical section 99, whose circular diameter becomes

smaller towards the end, are aligned in parallel. With the installation device 11 it is not only possible to produce and process longitudinal seams on a straight fuselage section 98 with a contour 980 that extends parallel to the X-direction, but also on a three-dimensional spatial section that extends at an angle in relation to the X-direction. To this purpose the plane carrier frame 4 in a frame plane 400 that is common to all components 41 to 44 is arranged so as to provide rotary adjustment on a central axis 401 that is perpendicular to said frame plane 400.

Depending on corresponding height positions of the bearings 511 in the Z-direction, the frame plane 400 comes to rest in horizontal planes. Each end piece 43, 44 on its side facing the bearing 511 comprises a convex circular segment which is determined by a radius 402 on the axis 401, which radius is situated in the area 400. Correspondingly each bearing 511 comprises a convex matching bearing shell in order to accommodate the associated end piece 43, 44 in the plane 400 so that it is rotatably pivotable on the axis 401.

In order to set up the position of the carriers 41, 42, which position matches the straight inclined contour, the frame 4 with the towers 61, 62 is first moved in a linear way in the Y-direction into the desired circumferential position and height position, with the towers 61, 62 aligned parallel to the X-direction, and with the bearings 511 movable in a linear way perpendicular to the Y-direction. By rotation on the rotary axis 500 the tool carriages 310, 320 in the set circumferential position are moved to a 90° working position in relation to the wall of the cylindrical section 98. By rotating the frame 4 on the axis 401 parallel alignment in relation to the contour 990 of the conical section 99 then takes place.

According to a further exemplary embodiment according to Figs 8 to 13 an installation device 1, 12 according to the invention instead of the carrier frame 4 comprises an inner portal device 7 which holds an inner tool guide carrier 21 as well as comprising an outer portal device 8 that carries an outer tool guide carrier 22. The inner portal device 7 comprises two column-like mounting parts that are formed by towers 72, 73, which mounting parts hold a portal carrier 71 so that it is movable in height direction Z and so that it is adjustable. The portal carrier 71 is formed by an inner longitudinal section 711 that forms the guide carrier 21, as well as on the ends by bearing sections 712, 713, wherein the longitudinal section 711 is held by means

of rotary-ring bearings 74, to the bearing sections 712 and 713 so as to be rotatable on a longitudinal rotary axis 501.

5 The outer portal device 8 is designed correspondingly. It comprises two mounting parts that form towers 82, 83, on which a portal carrier 81 is held so as to be movable and adjustable in height direction Z. The portal carrier 81 is formed by an inner longitudinal section 811 that forms the outer guide carrier 22, as well as by bearing sections 812, 813 at its ends. The central longitudinal section 811 is rotatably held to the end sections 812, 813 on a longitudinal rotary axis 502 by means of a rotary-ring bearing 84. The portal devices 7, 8 are separately movable in Y-direction on rails 15 or 16.

15 Apart from the fact that in the exemplary embodiment of Figs 8 to 13 the central longitudinal portal sections 711, 811 form the guide carriers 21, 22 that are parallel to the straight longitudinal contour 980, said guide carriers 21, 22 with the tool carriages 310, 320 and the tools 31, 32 form a pair 2 of tool guide carriers as is the case in the previously described exemplary embodiment. For the purpose of producing riveted seams 97, for example the positions shown in Figs 12A to 12C can be reached and set, which positions correspond to the positions in Figs 6A to 6C. In order to set a working position for processing a seam 97 the tower pairs 72, 73 and 82, 83 are separately moved in the Y-direction and are spaced apart in a manner suitable for the desired position. By means of linear actuating movement the portal carriers 71, 81 are moved in the Z-direction into height positions in which subsequently the longitudinal sections 711, 811 that form the longitudinal guide carriers 21, 22 are pivoted in the directions R2, R3 by rotary movement on the axes 501, 502 in order to mutually align the tool carriages 310, 320 with the tools 31, 32 as a pair 3 in a uniform direction of work at an angle of 90° in relation to the generated surface to be processed.

30 The portal carrier bearing sections 712, 713 or 812, 813 are held in bearings 521 or 531 that are movable and fastenable in height direction Z on the towers 72, 73 or 82, 83 in vertical bearing grooves 712 or 812, for example by means of threaded spindles (not shown).

35 In a circumferential region of approximately 270° the tool carriages 310, 320 can be moved into their working positions, wherein only the region of the component

carriage 13 that holds the fuselage 9 remains left open. For example, all the positions can be set on the fuselages in Fig. 7, which fuselages differ in size and shape.

Figs 10 and 11 provide exemplary embodiments of designs of the installation device 12 for the purpose of moving the fuselage jacket body 9, which circumferentially is completely closed, into the device and removing it from the device, in particular also in connection with the removal and insertion of a fuselage for carrying out a change in tool planes between the floor regions separated by floors 93, 94, 95.

10 The inner portal device 7 comprises the tower 72 which is provided as the main tower. On it the portal carrier 71 with a drag bearing 75 is pivotably held on an axis 750 that extends in Y-direction. In this arrangement the rotary bearing 521 that holds the portal carrier 71 is designed so as to be rotatable on the axis 750, wherein the height adjustability of the bearing 521 on the tower 72 remains intact.

15 On its other end the portal beam 71 is connected to the tower 73 that forms a support tower. In order to free the space on the face in front of the portal carrier 71, the portal carrier 71, which for lifting is supported by the tower 73, is raised in the Z-direction by a few degrees, e.g. approximately 5° , by pivoting on the axis 750. As shown in 20 Fig. 11, the freed support tower 73 is moved in Y-direction into a rear position. As a result of this the inner portal carrier 71 becomes free for the placement and removal of a fuselage 9. For the purpose of changing plane, the free portal carrier 71 is moved to the desired height position by moving the main tower 72 in Y-direction and by moving the bearing 521 on said tower in Z-direction. Correspondingly, the rotary 25 bearing 521 for the portal carrier 71 on the support tower 73 is moved to the same height position in order to be moved to the Y-position corresponding to the tower 72 for the purpose of closing the bridge 7.

The bearing 521 on the main tower 72 comprises a weight mass 79 that generates a 30 lever weight that counteracts the lever weight of the portal carrier 71 in order to hold the portal carrier 71 in its raised position pivoted by a small pivot angle, as shown in Fig. 10.

35 Expediently, as is shown in the exemplary embodiment of Fig. 13, the installation device 12 that comprises the portal devices 7, 8 can comprise portal carriers 71, 81 that can be held at an inclination to the X-Y-plane and that are aligned parallel to the

X-Y-plane for the purpose of carrying out longitudinal seam processing also on a contour 990 extending at an inclination to the X-direction, for example on a cone section 99. To this effect the drag bearing 75 of the inner portal device 7 can be used, wherein an accordingly large pivot region is provided. Correspondingly, the tower 82
5 of the outer portal carrier 81 is held by means of a fixed bearing which makes it possible to set a carrier position that is tilted in the Z-direction. On the other tower 83, as is the case on the tower 73 for bearing 531, a support bearing or a movable bearing is provided in order to be able to set up the inclined position so that it is adjustable.

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All the processes are automatically controlled, by means of normal machine controls, according to the prefabricated fuselage to be processed.

CLAIMS

1. An installation device (1) for connecting shell-shaped longitudinal segments
5 (910) of a jacket body (9) that forms a large component that extends longitudinally, that determines a hollow space (92) with an open face, and that is closed in particular on the circumferential side, by placement of at least one longitudinal connection seam (97) on the body jacket (91), said installation device (1) comprising at least one tool pair (3) which comprises
10 an inner tool (31) that is movably guided within the hollow space (92) in longitudinal direction (L) of the jacket body (9), and further comprises an outer tool (32) that is movably guided outside the hollow space (92) in longitudinal direction (L) of the jacket body (9), wherein for the purpose of producing the connection seam (97) the tools (31, 32) act together as a pair
15 (3) in the direction across the longitudinal direction (L) of the body, **wherein** the installation device (1) comprises a carrier pair (2) which is formed by an inner guide carrier (21) that extends in longitudinal direction (L) of the body and movably guides the inner tool (31) within the hollow space (92) of the jacket body (9), and further comprises an outer guide carrier (22) that extends
20 outside the jacket body (9) in longitudinal direction (L) of the body and movably guides the outer tool (32), wherein each guide carrier (21, 22) is rotatably held according to at least one longitudinal rotary axis (500, 501, 502) oriented by an outer longitudinal contour (980, 990) of the jacket body (9), as well as being slidably held and fastenable in at least two separate
25 spatial directions (Y, Z) that extend across the longitudinal direction (L) of the body, wherein the tools (31, 32), which interact for producing the connection seam (97) selectively take up different positions on the longitudinal circumference of the jacket body (9) as a pair.
- 30 2. The installation device of claim 1, **wherein** at least one tool pair (3) is designed for establishing a riveted connection.
3. The installation device of claim 2, **wherein** the tool pair (3) comprises
35 riveting tools (31, 32) that place rivets into the jacket body (9) free of any force introduction.

4. The installation device of any one of claims 1 to 3, **wherein** the installation device (1) for the placement of at least one longitudinal connection seam (97) is designed to produce a jacket body (9) which at least along one longitudinal section (98) is at least approximately cylindrical in shape.
5. The installation device of any one of claims 1 to 4, **wherein** the device for the placement of at least one longitudinal connection seam (97) is designed to produce a jacket body (9) which at least along one longitudinal section (99), in particular an end section, is conical.
6. The installation device of any one of claims 1 to 5, **wherein** each tool guide carrier (31, 32) is rotatably displaceable on associated longitudinal rotary axes (500, 501, 502) and is translative displaceable to and fro manner in two separate transverse directions (Y, Z) that are perpendicular in relation to each other, wherein preferably one transverse direction (Y) is determined by a horizontal plane (X-Y) while the other transverse plane is determined by a vertical direction (Z) that is perpendicular in relation to the aforementioned plane.
7. The installation device of any one of claims 1 to 6, **wherein** the installation device (11) comprises a carrier frame (4) that extends in longitudinal direction (L), which carrier frame (4) forms the carrier pair (2) and is rotatably held on a bearing axis that preferably coincides with a longitudinal symmetry axis (40) of the carrier frame (4), which axis forms a mutual longitudinal rotary axis (500) for the two guide carriers (21, 22).
8. The installation device of claim 7, **wherein** the carrier frame (4) at its faces comprises the frame webs (43, 44) that connect the two guide carriers (21, 22; 41, 42) of a carrier pair (2), which frame webs (43, 44) are rotatably held by at least one longitudinal axis (40) of the carrier frame (4), wherein on at least one frame end the frame web (43) is detachably connected to the frame guide carriers (41, 42) and that said frame web (43) in the detached state can be moved to a position that provides access to a front space in front of the inner guide carrier (41).

9. The installation device of claim 8, **wherein** the carrier frame is, at its end that faces a frame end that comprises a fully detachable frame web (43), provided with a weight mass (45) that generates a counterbalance weight so as to hold the carrier frame (4) in position in the state where the frame web (43) is completely separated from the frame guide carriers (41, 42).
10. The installation device of any one of claims 7 to 9, **wherein** the carrier frame (4) is held in such a way that it can be relocated as desired to at least two positions (19) in which each of the frame guide carriers (41, 42) is aligned according to the different outer longitudinal contour (980, 990) of the jacket body (9).
11. The installation device of claim 10, **wherein** the installation device (11) comprises a bearing device (51) that holds the carrier frame (4), which bearing device (51) on the frame webs (43, 44) in their direction of extension comprises curved bearing sections, as well as corresponding bearing sections that accommodate said curved bearing sections.
12. The installation device of any one of claims 7 to 11, **wherein** the installation device (11) comprises column-like mounting parts (61, 62) between which the carrier frame (4) is arranged and on which it is held so as to be rotatable on a longitudinal axis (40), wherein the column-like mounting parts (61, 62) in at least a first spatial direction (Y) across the longitudinal direction (L) of the jacket body (9) are arranged so as to be mutually movable and fastenable.
13. The installation device of any one of claims 7 to 12, **wherein** the column-like mounting parts (61, 62) carry rotary bearings (511) that hold the frame carrier (4) and that are adjustable in the spatial direction (Z) across the longitudinal direction (L) of the jacket body (9) as far as the column height of the mounting parts (61, 62) is concerned.
14. The installation device of any one of claims 1 to 6, **wherein** the installation device (12) comprises an inner portal device (7) that holds at least one inner guide carrier (21), and further comprises at least one outer portal device (8) that holds at least one outer guide carrier (22), wherein the inner guide carrier (21) is rotatably adjustable on a longitudinal rotary axis (501) of the inner

portal device (7), while the outer guide carrier (22) is rotatably adjustable on a longitudinal rotary axis (502) of the outer portal device (8).

15. The installation device of claim 14, **wherein** at least one portal device (7, 8) comprises a portal carrier (71, 81), which is formed by at least one inner longitudinal section (711, 811) that forms a guide carrier (21, 22), as well as by bearing sections (712, 713; 812, 813) at its ends.
16. The installation device of claim 14 or 15, **wherein** in each case the inner portal device (7) and the outer portal device (8) comprise two column-like mounting parts (72, 73; 82, 83) (7, 8), between which in each case the associated portal carrier (71, 81) is arranged and on which mounting parts it is held, wherein the column-like mounting parts (72, 73; 82, 83) of each portal device are arranged so as to be mutually movable in at least a first spatial direction (Y) across the longitudinal direction (L) of the jacket body (9) and are arranged so as to be fastenable, and carry rotary bearings (521, 522; 531, 532) which hold the portal carrier (71, 81) and are adjustable in at least one second spatial direction (Z) across the longitudinal direction (L) of the jacket body (9).
17. The installation device of claim 16, **wherein** on the column-like mounting parts (72, 73; 82, 83) of the inner portal carrier device (7) and of the outer portal carrier device (8) height-adjustable and arrestable support bearings (76, 86) for the portal carriers (71, 81) are arranged in such a way that said portal carriers (71, 81) in parallel position in relation to each other can selectively be moved to at least two positions in which they are aligned according to the varying outside longitudinal contour (980, 990) of the jacket body (9).
18. The installation device of any one of claims 14 to 17, **wherein** the inner portal device (7) comprises column-like mounting parts (72, 73) on which the inner portal carrier (71) is detachably held in such a way that in the detached state at least one mounting part (73) can be moved to a position that provides access to a front space in front of the inner portal carrier (71).
19. The installation device of claim 18, **wherein** the inner portal device (7) is pivotably held to a first column-like mounting part (72), on which the inner

portal carrier (71) is pivotably held in the direction of the column height, as well as being held to a second column-like mounting part (73) on which for pivoted lifting the inner portal carrier (71) is liftably held in order to release the second column-like mounting part (73) for the process.

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20. The installation device of claim 19, **wherein** at its pivotably held end the outer portal carrier (71) comprises a weight mass (79) which generates a lever weight that lifts the other end of the inner portal carrier (71).

Abstract

For producing a longitudinal connection seam an installation device (1) for connecting shell-shaped longitudinal segments (910) of a jacket body (9) that forms a large component determines a hollow space with an open face, comprises at least one tool pair (3) which comprises an inner tool (31) that is movably guided within the hollow space in longitudinal direction (L) of the jacket body (9), and further comprises an outer tool (32) that is movably guided outside the hollow space (92) in longitudinal direction (L), wherein the tools (31, 32) act together as a pair (3) in the direction across the longitudinal direction (L) of the body. The installation device (1) comprises a carrier pair (2) which is formed by an inner guide carrier (21) that extends in longitudinal direction (L) and movably guides the inner tool (31) within the hollow space (92) of the jacket body (9), and further comprises an outer guide carrier (22) that extends in longitudinal direction (L) outside the jacket body (9) and movably guides the outer tool (32). Each guide carrier (21, 22) is rotatably held and fastenable according to at least one longitudinal rotary axis (500) oriented by the outer longitudinal contour (980) of the jacket body (9), as well as being slidably held and fastenable in at least two separate spatial directions (Y, Z) that extend across the longitudinal direction (L) of the body, such that the tools (31, 32) acting together as a pair (3) selectively take up different positions on the longitudinal circumference of the jacket body (9).

(Fig. 1)